MARKETING RESEARCH REPORT NO. 985

STRUCTURE OF SEASONAL SUPPLY AND DEMAND IN THE ONION MARKET

ONOMIC RESEARCH SERVICE
S. DEPARTMENT OF AGRICULTURE

ABSTRACT

This study examines year-to-year price and output variation for three seasonal onion crops. Econometric models are developed and estimated for two disjoint time periods. The first period encompasses the crop years 1946/47-1958/59, when onion futures contracts were actively traded on the Chicago Mercantile Exchange; the second period, 1959/60-1969/70, covers years following futures trading. The results failed to divulge significant differences in the structure of supply and demand between the two periods. Observations for the combined period were subsequently used to quantify the seasonal supply-demand structure.

Key words: Onions, supply, demand, futures-trading, marketing.

Washington D.C. 20250 February 1973

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SUMMARY

Tests based on two-equation models constructed for three seasonal onion crops indicated no significant differences in supply and demand structure for any of the crops between two historical periods—one of active trading on the futures market and one following trading. The models were designed to detect any structural changes in pricing mechanisms during 1930-70 which were not necessarily associated with the presence or absence of an active futures market. A comparison of seasonal onion supply and demand for the periods before, during and after futures trading was intended; however, data inadequacies limited analysis to the futures trading (1946/47-1958/59) and post-trading (1959/60-1969/70) periods.

The models were comprised of a supply function relating planted acreage to factors expected to affect growers' anticipated profitability conditions and a demand function relating season average farm price to seasonal production, competing crop size, and factors influencing final consumer demand. The models were estimated separately for the futures trading and post-trading periods. Equality of coefficients tests were used to determine whether estimated parameters were significantly different between the two periods. After these tests showed no significant differences for any of the three crops (late summer, early spring, and intermediate), pooled observations were used to quantify the structure of supply and demand.

Analysis of the models indicated the presence of a well-defined cobweb structure. Growers are influenced by past prices in determining onion plantings, while current prices reflect current production levels. Large crops result in low farm prices which, in turn, cause growers to reduce plantings in the following year. Resulting reductions in production yield strong prices, eliciting acreage increases. This underlying recursive structure creates substantial year-to-year variability in seasonal prices and production.

STRUCTURE OF SEASONAL SUPPLY AND DEMAND IN THE ONION MARKET

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INTRODUCTION

This report is part of an overall study of price performance in the onion market. The objective of the overall study is to assess the impact of futures trading in onions on cash onion prices. Students of agricultural prices have long been concerned with relationships between commodity cash and futures markets, and the possible impact of futures trading on cash markets. Advocates of futures trading claim that trading improves price performance in cash markets by providing an alternative means of reflecting commodity supply and demand conditions. They argue that futures markets also provide a hedging vehicle which permits buyers and sellers to reduce price uncertainty and associated uncertainty discounts. Opponents of trading, on the other hand, argue that trading tends to destabilize cash market prices, that futures markets are susceptible to manipulation, and that traders unfamiliar with market conditions practice excessive speculation.

Empirical verification of either view is a formidable task, largely because of a lack of data with which to structure meaningful comparisons of cash price performance with and without futures markets. Many agricultural commodities traded on futures exchanges have a long history of uninterrupted trading (wheat, corn), and published price data prior to trading are minimal or unavailable. For other commodities (pork bellies, livestock), the period of trading has not been long enough to allow appropriate assessment of the impact of trading on cash prices. Moreover, in any case of currently traded commodities, it is difficult to determine whether price performance in the cash market is being influenced by futures trading or by structural and institutional conditions within the market itself.

With respect to providing a satisfactory basis for study, onions are unique among traded commodities. A yellow globe onion contract was first introduced on the Chicago Mercantile Exchange in 1942. The contract was actively traded from after World War II until 1958, when trading was banned by Public Law 85-839. Consequently, an unusual historical experiment exists with lengthy data periods before, during, and after futures trading. Analysis of possible changes in cash onion price performance which occurred between the three time periods should provide some useful evidence regarding the impact of futures trading.

A crucial issue related to interpretation of the results of such an analysis is whether any observed differences in cash price performance are attributable to fundamental changes in the structure of the pricing mechanism wholly unrelated to trading. Changes in demand or in the behavior of producers could yield performance changes which could be misconstrued as resulting from futures trading. Hence, a prerequisite for appropriate consideration of the impact of onion futures trading on cash price performance—the purpose of the overall study mentioned above—is isolation of possible nonrelated structural changes in the pricing mechanism.

The present study focuses directly on this issue. Specifically, its purpose is to describe and analyze the structure of the cash onion market to provide a framework for further study of the influence of a futures market. Its four main objectives are:

(1) To describe the production and marketing processes in the onion industry.
(2) To specify factors influencing seasonal average prices and production.
(3) To develop and estimate a statistical model incorporating these factors to represent the structure of supply and demand.
(4) To assess possible differences in the basic structure of onion supply and demand between the futures trading and post-trading periods.

This report is restricted to consideration of year-to-year price and output variation for three seasonal onion crops. A subsequent report—also part of the overall study—will consider intraseasonal price movements for the dominant late summer crop.

A DESCRIPTION OF THE ONION INDUSTRY

Production

Onions are an important U.S. vegetable crop.[1] Production is widespread—16 Eastern, Midwestern, and Western States had a combined onion acreage of over 100,000 acres in 1970. Grower receipts averaged about $1,000 per acre, representing a total farm value of more than $100 million (*13*).[2]

Three major seasonal onion crops can be distinguished according to geographical production regions, planting and harvesting dates, and varieties planted.[3] These crops are denoted late summer, early spring, and intermediate, corresponding to the calendar time of maximum harvest activity. Figure 1 illustrates the approximate planting and harvesting dates for the three seasonal crops. Table 1 shows the relative importance of each in terms of total crop year production.[4] Planted and harvested acreage, production, yield, and price data for each of the seasonal crops are provided in appendix A.

Table 1—Share of yearly onion production from each seasonal crop, 10-year averages, 1930/31-1969/70

Period	Late summer	Early spring	Inter-mediate
	Percent	*Percent*	*Percent*
10 year average:			
1930/31-1939/40 ...	72.8	12.5	14.7
1940/41-1949/50 ...	76.1	10.4	13.5
1950/51-1959/60 ...	72.7	10.3	17.0
1960/61-1969/70 ...	71.0	10.9	18.1

Sources: (*6*) (*7*) (*13*).

Late Summer

The late summer crop is the largest of the three seasonal onion crops, averaging over 70 percent of total production from 1930/31 to 1969/70.[5] Late summer onions are produced over a larger geographical area than the other crops. Major production regions are in New York State and several Midwestern and Western States. Table 2 shows that production of late summer onions has been increasing for the group total as well as for most of the individual States within the group. The largest increase has been in California, where production almost doubled during each of 10-year intervals shown. The Western States of Idaho, Oregon, Colorado, and California have become increasingly important late summer onion producers. The combined production of those States averaged 27.3 percent of total late summer production during 1930/31-1969/70; it reached 52.6 percent in the last decade of the period. In contrast, Michigan and New York State, while exhibiting absolute production increases, have about maintained their shares of total seasonal production.

Planting of the late summer crop begins in California as early as January for some direct-seeded varieties.

Table 2 —Late summer onion production in selected States, 1930/31-1969/70

State	10-year average			
	1930/31-1939/40	1940/41-1949/50	1950/51-1959/60	1960/61-1969/70
	1,000 cwt.	*1,000 cwt.*	*1,000 cwt.*	*1,000 cwt.*
Idaho ...	694.5	1,043.2	956.2	1,305.1
Oregon ...	499.3	1,137.5	2,000.5	2,477.0
Colorado ...	878.0	2,593.2	1,820.6	1,928.6
California ...	810.6	1,453.3	2,310.2	4,242.2
Michigan ...	1,654.6	1,851.2	2,388.3	2,448.8
New York ...	2,201.2	3,315.7	4,306.2	4,452.9
Other States ...	3,816.2	3,542.7	3,143.5	2,082.2
Total late summer ...	10,554.4	14,936.8	16,925.5	18,936.8

Sources: (*6*) (*7*) (*13*).

[1] Onions in this report are dry onions; that is, green onions, leeks, and shallots are excluded.

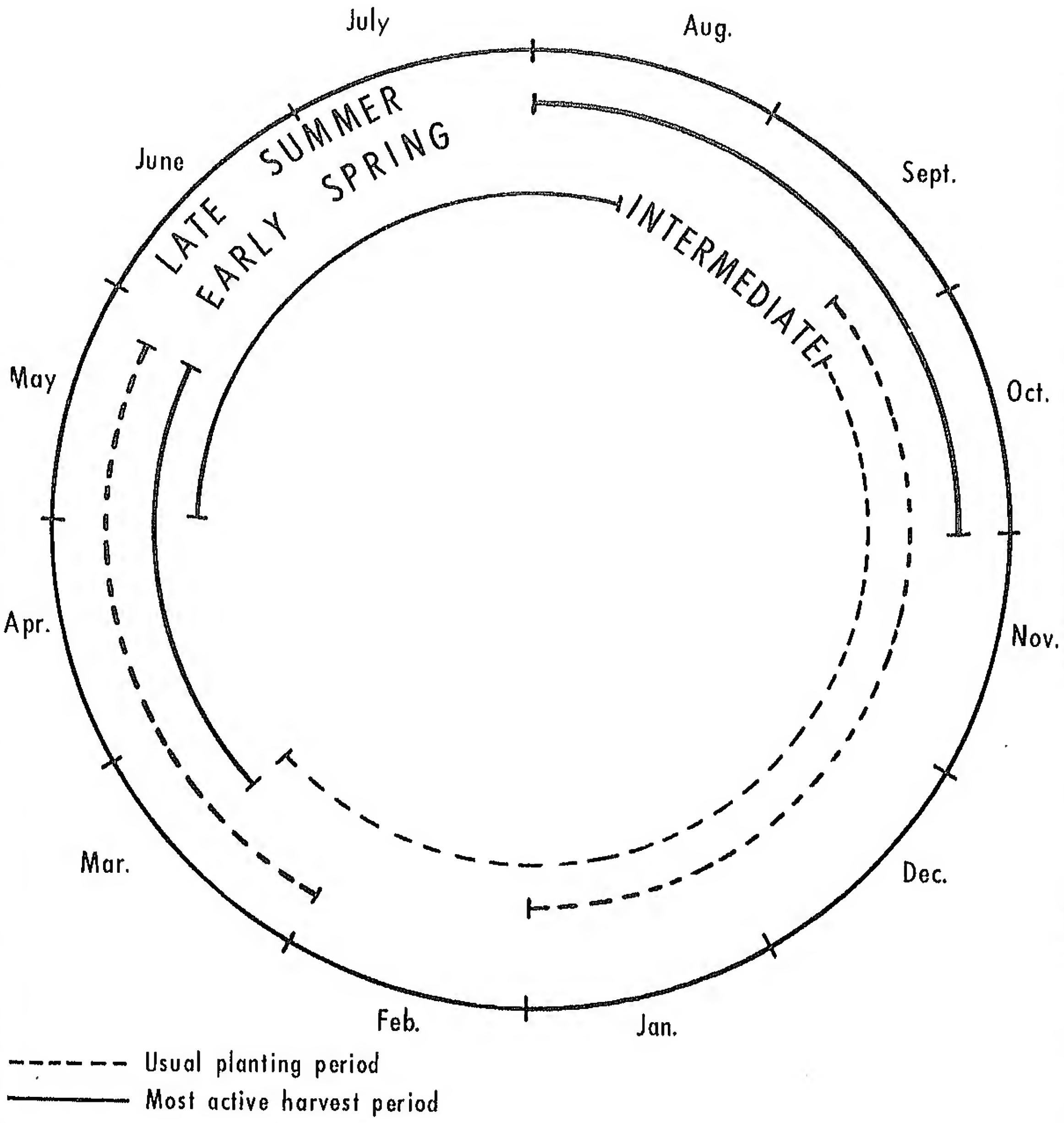
[2] *Italicized* numbers in parentheses refer to literature cited.

[3] The Crop Reporting Board, Statistical Reporting Service, USDA, recognizes 4 seasons: Late summer, early spring, late spring, and early summer. The late spring and early summer crops are very similar, involving comparable areas of production and varieties, and overlapping planting and harvesting dates. Consequently, in this study, these 2 seasons are combined and denoted the intermediate season.

[4] The onion crop year is defined as beginning with the late summer harvest.

[5] Split years cited in text, tables, and figures in this report refer to crop years, as opposed to regular calendar years.

USUAL PLANTING AND HARVESTING DATES FOR SEASONAL ONION CROPS



SOURCE: (12).

U.S. DEPARTMENT OF AGRICULTURE NEG. ERS 9016-72 (12) ECONOMIC RESEARCH SERVICE

Figure 1

Other Western State growers begin planting in early March. Midwestern and Eastern growers are limited in their earliest planting date to the time of the last killing frost in the spring. Usual planting dates extend from early April to mid-May in Midwestern States. New York growers begin planting direct-seeded onions about March 20 and usually complete set transplants by May 25. The earliest harvesting begins in California in July. Most harvest activity is during September, and harvest is generally completed in all regions by October 31.

Most of the late summer onion crop is of the yellow globe variety, but milder Sweet Spanish and Valencia varieties are grown in some Western States. Late summer onions require cool weather during early growth and long sunshine periods during later bulb development, and are hence well adapted to Northern climates. This crop is predominantly direct seeded, but some acreage is grown from transplants for early harvest. Most of the crop from Midwestern and Eastern States is grown on muck soils with sufficient moisture-holding capacity to preclude the need for irrigation. Western Sweet Spanish varieties, on the other hand, are generally grown on irrigated mineral soils.

Early Spring

The entire early spring onion crop is produced in the Rio Grande Valley region of southern Texas.[6] Plantings are made primarily on irrigated land. Direct seeding begins in the northern part of the producing region in September. Setting of transplants in the lower valley is most active in November and early December. The start of the harvest season is highly variable, depending on prevailing weather conditions. Figure 2 shows the date at which the first shipments of the early spring crop were reported by USDA's Market News Service, and the dates at which early spring shipments exceed those from other producing regions (that is, the date at which shipments of the new crop exceed shipments of stored onions from the late summer crop). Almost 2 months separate the dates of the first and last shipments of early spring

[6] Onions produced in Northern Texas are later varieties and are included in the intermediate crop.

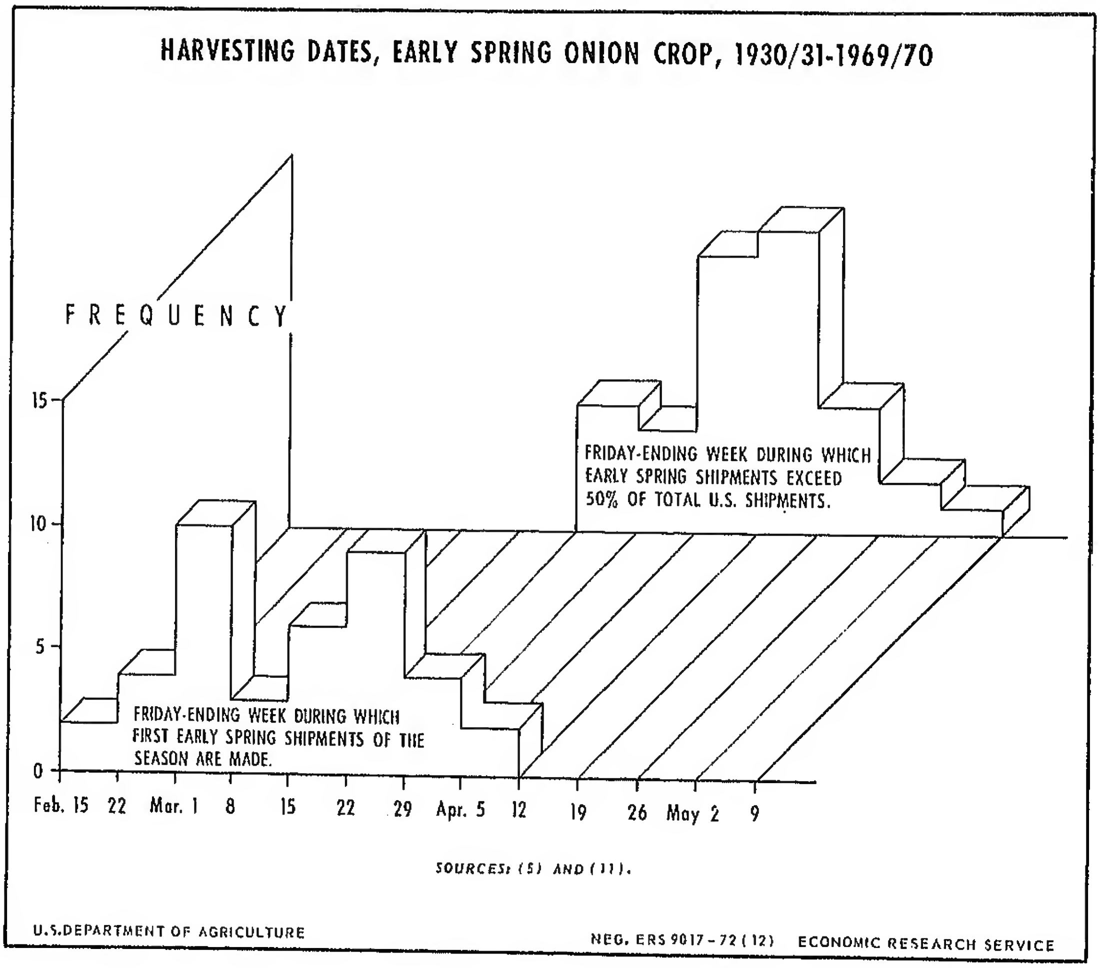


Figure 2

onions, while 7 weeks separate the earliest and latest dates at which this crop becomes the dominant source of supply.

Early spring onions are large, mild varieties commonly known as Bermudas. Yellow Bermuda was the commercial name of the variety predominant until about 1950, when a variety known as Grano became popular. Grano was in turn replaced by Granex, currently the most popular early spring variety.

Intermediate

The intermediate onion crop is grown primarily in the West and Southwest, with small acreage in New Jersey. California is presently the major producer of intermediate onions, supplying about 30 percent of total production (table 3). Texas is the second largest producer, with about one-fifth of the total group production. The trend in production for all the Western States has been upward. New Jersey production was practically stable during 1930/31-1969/70.

Intermediate onions are both direct seeded and transplanted. A number of different varieties are grown, including Granex, Sweet Spanish, and white globes. Planting of the intermediate crops occurs over a lengthy timespan. California growers begin planting in September and planting in Northern Texas regions continues until about May 1. The harvest season for the intermediate crop extends from about May 1 until mid-September.

Distribution

Distribution or marketing methods for onions differ according to seasonal category. Late summer onions are principally a storage crop. Most of the crop is field dried and placed directly into storage facilities at or near the point of production. The stored onions are then moved into marketing channels during winter months when newly harvested onions are not available. Onion storage does not require elaborate facilities. Weather conditions at harvest time generally permit storage without mechanical cooling. Onions are usually stored in insulated warehouses with facilities for temporary heating when temperatures drop below critical levels.[7]

In contrast to late summer onions, early spring and intermediate onions are marketed immediately following harvest and field curing. Temperatures and climatic conditions at harvest time do not permit storage without mechanical cooling; and even with this, the varieties grown are not amenable to storage. Harvesting within each seasonal group is distributed widely enough so that large gluts are seldom encountered.

Movement from grower to retail distributor is similar for the three seasonal crops. Three major types of distributors are employed; broker-shippers, grower-shippers, and chainstore buyers. Broker-shippers do not actually gain title to the commodity. For a fixed fee, they arrange carlots—usually from growers too small to ship whole cars—for shipment to terminal markets. Grower-shippers, in contrast, are generally large enough to maintain sales contacts and ship without the assistance of a broker. Many grower-shippers purchase additional onions from nearby growers to supplement their own crops. Frequently, these grower-shippers are also repackers—they pack and ship onions in consumer-size packages ready for immediate sale at retail outlets. The third major sales channel at the farm level is through chainstore buyers. They purchase onions in bulk at the farm and ship them to retail stores or central packing houses for repacking in consumer-size packages. Direct chainstore purchases and grower-shipper repacking to retail store specifications have increased

[7] Some of the late summer crop is placed in cold storage to increase the storage life, but this practice is decreasing. January 1 cold storage stocks were an average 23.3 percent of total storage stocks for the 1945/46-1949/50 late summer seasons. The comparable figure for 1965/66-1969/70 was 4.4 percent (*11*).

Table 3 —Intermediate onion production in selected States, 1930/31-1969/70

State	10-year average			
	1930/31-1939/40	1940/41-1949/50	1950/51-1959/60	1960/61-1969/70
	1,000 cwt.	*1,000 cwt.*	*1,000 cwt.*	*1,000 cwt.*
Washington	170.2	200.0	214.8	221.9
California	636.5	1,078.9	1,285.3	1,376.9
Arizona	([1])	166.2	517.0	733.4
New Mexico	([1])	148.3	366.9	866.2
Texas (North)	559.0	442.9	848.4	1,168.8
New Jersey	443.4	317.6	353.9	376.6
Other States	332.4	313.7	373.1	91.6
Total intermediate	2,141.5	2,667.6	3,959.4	4,835.4

[1] No production reported.

Sources: (*6*) (*7*) (*13*).

substantially over time. As a consequence, a declining proportion of total onion production is being sold through terminal wholesale produce markets.

Sales at terminal markets are generally made in two different ways. In some cases, purchases from brokers and grower-shippers are made by wholesalers, who repack at terminal markets and sell consumer-size packages to retailers. Other terminal market sales are classified as street sales—sales of bulk containers directly from receivers to retailers. Jobbers and retailers then repack, or display and sell onions in bulk.

Onion supplies at the retail level are quite consistent over the year. The relatively constant flow is assured by the good storability of the late summer crop and the diverse harvesting dates of the other seasonal crops. Table 4 shows the monthly distribution of reported unloads for the total United States and for selected producing regions. Monthly unloads vary little for the United States as a whole, although there is substantial variation among the seasonal States. Unloads are slightly larger during summer months when storage is not feasible, and slightly smaller during winter months when storage supplies are being sold.

Processed onion products have become increasingly important in recent years, but little information is available on the amount of total production used in processing. Most onion processing plants are in California. It is estimated that more than two-thirds of all onions produced in California—including a substantial proportion of its intermediate crop—are utilized by processors.

The most common processed onion products are dehydrated onions (primarily flakes, salts, and powder), canned whole small onions, and frozen french-fried onion rings. Grieg estimated that in 1961, dehydrated products accounted for 10.6 percent of the commercial onion crop, while canned onions and frozen rings each accounted for 1.3 percent *(1)*. Although more recent estimates are not available, there is evidence to indicate that the proportion of onions used for frozen rings has increased dramatically since 1961. Other processed onion products include frozen diced onions, pickled onions, onion juice, and specialty products. Onions are also used as secondary ingredients in products such as soups, sauces, and salad dressings.

Consumption

Per capita onion consumption has been quite stable over time (fig. 3), particularly since the early 1950's. No discernible trend is apparent; fluctuations have been primarily about the the 1930-69 mean value of 11.8 pounds per person. Since harvested crops are generally marketed in their entirety—except for storage losses in the case of late summer onions—consumption over the year matches production, and variation in per capita consumption is attributable to year-to-year changes in production. With more and more onion acreage under irrigation, production variability has diminished, resulting in less variability in per capita consumption.

According to the 1965 Food Consumption Survey, geographical region and degree of urbanization cause little difference in onion consumption *(8)*. Consumption by income classes shows a consistent pattern for all urbanization and regional classes. Weekly household consumption increases as money income before taxes

Table 4 —Distribution of reported onion unloads by month, total United States and selected seasonal crop States, calendar year 1969 [1]

Month	Total U.S. unloads	Producing region			
		Michigan	South Texas	Arizona and New Mexico	Imports[2]
	Percent	*Percent*	*Percent*	*Percent*	*Percent*
January	8.0	13.1			14.3
February	7.0	12.0	0.6		14.2
March	7.2	13.4	9.4		14.3
April	8.8	5.6	54.3		9.6
May	9.4	0.5	35.7	11.8	4.2
June	9.1	0.4		48.2	5.2
July	9.0	1.1		20.1	6.2
August	8.4	5.0		17.2	4.0
September	8.9	11.9		1.6	0.9
October	8.6	14.1		0.6	1.5
November	7.3	11.4		0.4	8.8
December	8.2	13.7			16.7
1969 reported unloads in carlot equivalents	30,834	2,409	[3]6,314	1,657	1,013

[1] Reported unloads are estimated to represent 60 percent of total unloads. Selected States are chosen to represent seasonal crops—Michigan is a late summer producer, South Texas is the sole early spring producer, and Arizona and New Mexico are intermediate season producers. Percentages may not add to 100.0 because of rounding. [2] In 1969, the United States imported onions from Mexico, Canada, Chile, and Italy. [3] For South Texas, shipments rather than unloads were utilized in calculating monthly distribution to filter out Texas shipments of intermediate crop onions.

Source: *(11)*.

increases from less than $1,000 to $7,000 - $8,000. As income increases beyond $8,000, weekly household onion usage declines.

The per capita consumption data in figure 3 include onions in processed as well as fresh form. Although a breakdown between the two types is unavailable, evidence from private sources suggests that processed forms are being substituted for fresh onions at a significant rate. This substitution has implications for the future location of production, since varieties used for processing tend to favor Western and Southwestern producing regions.

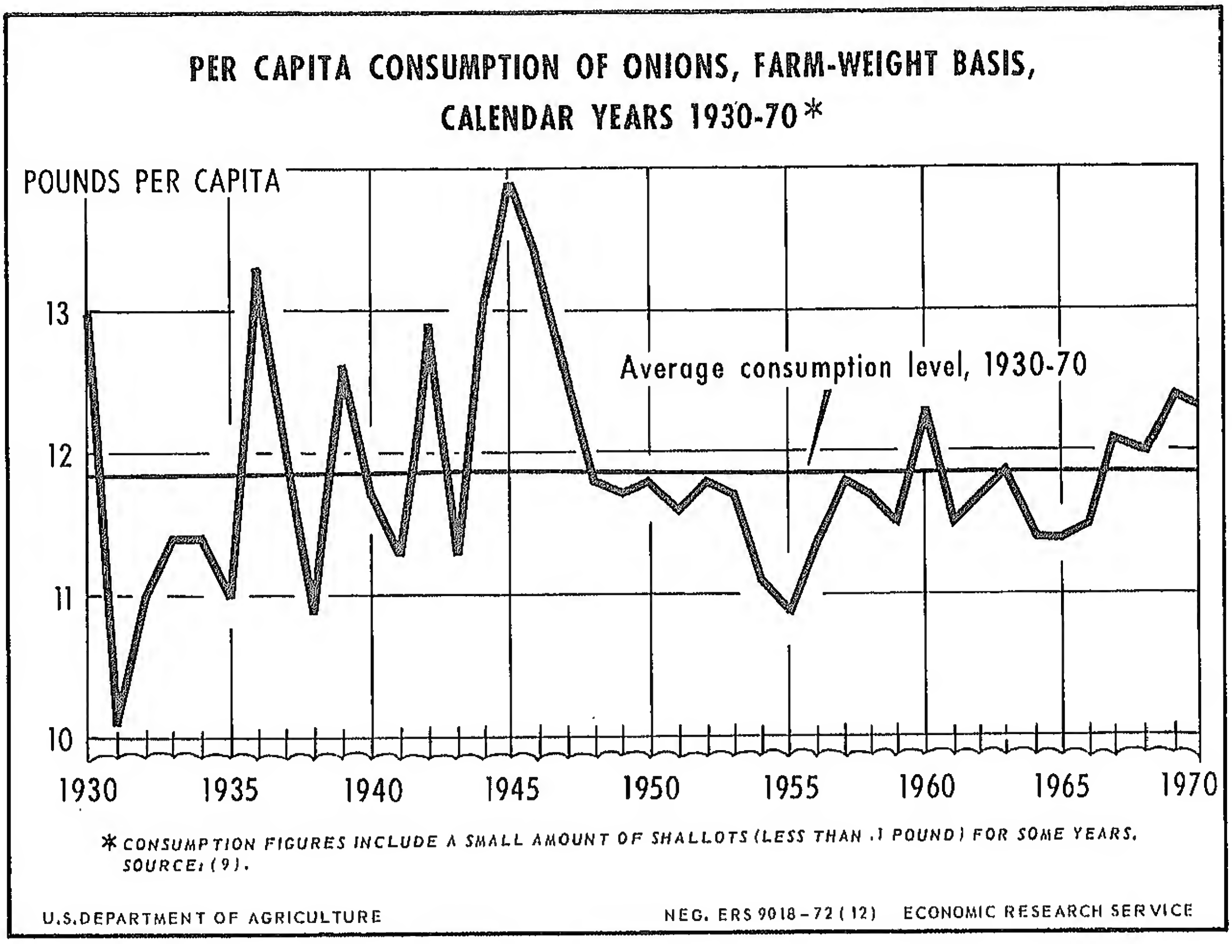


Figure 3

THE STRUCTURE OF SEASONAL ONION SUPPLY AND DEMAND

General Model

Figure 4 portrays the general structure of supply and demand applicable to the late summer, early spring, and intermediate crops. At the beginning of the season, growers determine planted acreage based on their expectations regarding the profitability of onion production relative to alternative uses for their resources. These expectations are not observable, and may not even be quantifiable. However, factors influencing expectations are likely to be the average price received in the preceding year and the price of onions from the seasonal crop being sold at the time of planting.

Onion acreage planting in the previous year is shown to influence planted acreage in the current season (fig 4). The effect of lagged acreage is due to certain frictions preventing large year-to-year changes in plantings. These may be described as technological and psychological. Technological frictions relate to growers' inability to rapidly alter stocks of production capital. To some extent, growers may be locked in to a certain range of acreage in the short run. Ownership of specialized cultural equipment prevents rapid changeover to alternative crops when low prices are expected, while a limited quantity of suitable soil restricts acreage increases when prices are expected to be high. Psychological frictions refer to producer response to price uncertainty. Since production plans are formulated as long as 6 months prior to the time the crop is sold, growers are not able to accurately project profitability conditions at planting.[8] The possibility of serious financial losses resulting from gross differences between actual and projected prices tends to diminish large year-to-year changes in plantings.

Technology is another factor expected to affect plantings. Changes in cultural practices or the introduction of new equipment could alter the onion production process and the response behavior of growers.

Total seasonal onion production is the product of planted acreage less that portion abandoned prior to harvest and yield per acre. Unharvested acreage as a percentage of planted acreage is variable among the three seasonal crops. During 1946/47-1969/70, unharvested acreage averaged about 4 percent of planted acreage for the late summer crop. The comparable percentages for the early spring and intermediate crops were 12 and 4, respectively. Attempts to relate unharvested acreage to measures of harvest price failed to disclose a causal relationship.[9] Consequently, it is believed that unharvested onion acreage results largely from inclement weather conditions at harvest, rather than from harvest costs exceeding grower prices.

Onion yields also are largely influenced by weather conditions at harvest and during other parts of the growing season. Nonetheless, an upward trend in yield is observed for all three of the seasonal crops (app. table A). Improved technology—mainly better equipment, fertilizers, pesticides and herbicides, and higher yielding onion varieties—is responsible for this trend.

Season average farm price is determined by the magnitude of production, available quantity of onions from other seasonal crops, and factors affecting consumer demand. Harvest periods for the three crops overlap (fig. 1). In addition (not shown in the diagram), the sales-from-storage period for the late summer crop extends beyond the beginning of harvest for the early spring crop. Consequently, onions from each of the three crops compete with onions from other seasonal crops, both at the beginning and end of their seasons. This suggests that each season average price is affected by total crop year production, as well as by seasonal production.

Since grower-level onion demand is derived from consumer demand, demand shifters at the consumer level influence farm prices. Two such shifters are shown in figure 4—changes in the level of consumer income and shifts in tastes and preferences.

Statistical Model

Onion supply and demand models for the late summer, early spring, and intermediate crops were developed based on the general model illustrated in figure 4. Planted acreage was selected as the dependent variable in the supply equations, and season average farm price as the dependent variable in the demand equations. Observable variables were selected to represent or act as proxies for the influencing factors shown in the diagram.

[8] This was not the case during the period of futures trading in onions, when growers could ensure harvest price through hedging. Although use of hedging by growers at planting appeared to be minimal during this time, it should be noted that this discussion abstracts from its use.

[9] In contrast, Suits and Koizuma (*4*) estimated an unharvested crop relation for all seasonal crops combined which showed a negative relationship between third quarter New York City wholesale onion price and the quantity of onions unharvested during 1924-51. The level of significance of the relationship was not specified, however, and the quantity variable used appears suspect. Specifically, it is cast in pounds, which indicates that yield on harvested acreage was applied to the unharvested crop. But in practice, abandoned acreage would be the lowest yielding portion of planted acreage.

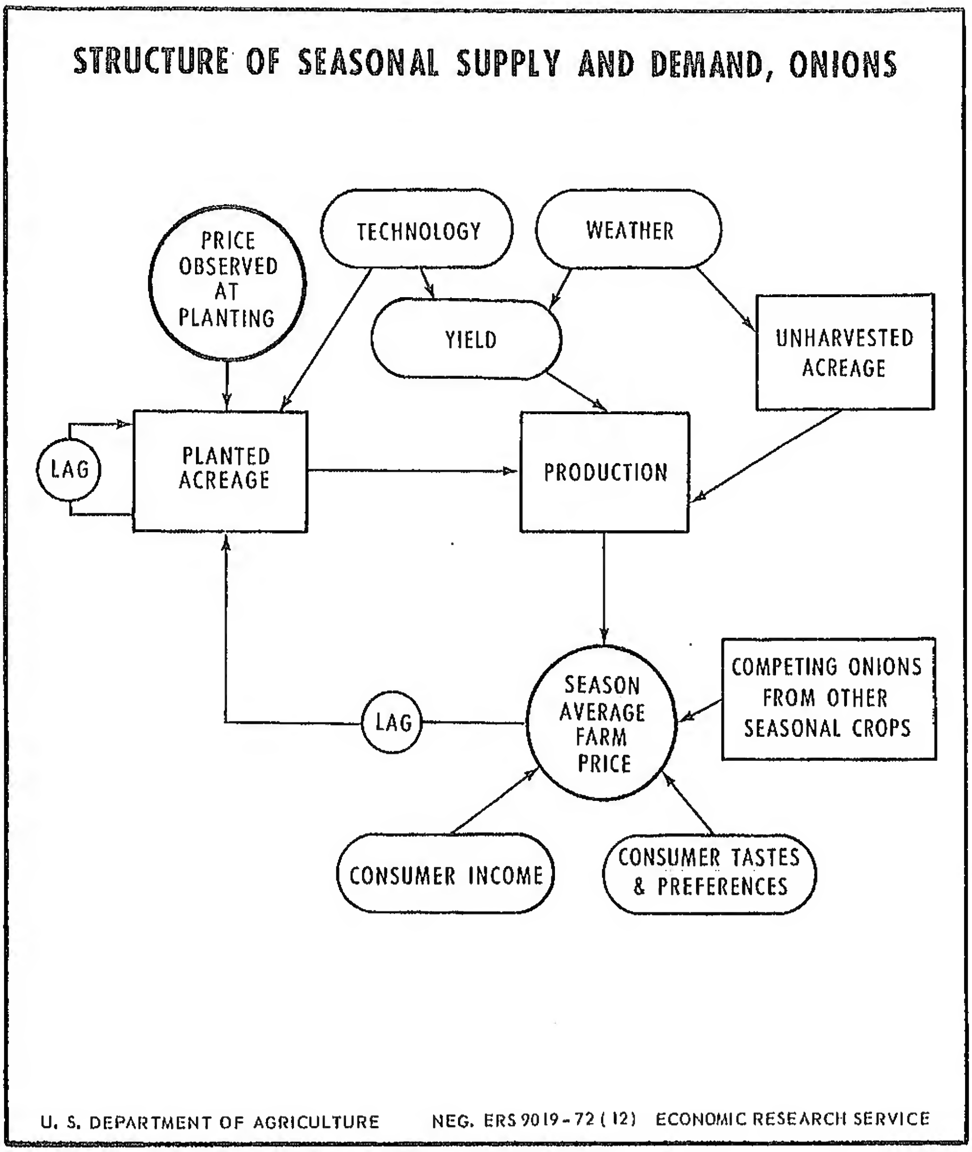


Figure 4

The resulting general formulations are:

(1) $ACRES_{i,t} = f\,(ACRES_{i,t-1}, PRICE_{i,t-1}, OBSPRICE_{i,t}, TREND_{i,t})$

(2) $PRICE_{i,t} = f\,(PROD_{i,t}, LEADPROD_{i,t}, LAGPROD_{i,t}, INCOME_{i,t}, TREND_{i,t})$

The subscripts and variables are defined as follows:

i = season, 1 = late summer
2 = early spring
3 = intermediate.

t = crop year, 1946/47 = 1, . . ., 1969/70 = 24.

ACRES = planted acreage in acres per million population.

PRICE = season average grower price for onions in dollars per hundredweight, deflated by index of prices received by farmers for all products, 1957-59 = 100.

OBSPRICE = season average grower price for onions for the seasonal crop being sold at the beginning of the planting period. (This is determined from fig. 1.) Explicitly,

$$OBSPRICE_{1,t} = PRICE_{2,t-1}$$
$$OBSPRICE_{2,t} = PRICE_{1,t}$$
$$OBSPRICE_{3,t} = PRICE_{1,t}$$

TREND = crop year, 1946/47 = 1, . . ., 1969/70 = 24.

PROD = seasonal onion production in pounds per capita.

LEADPROD = per capita onion production in pounds for *following* seasonal crop:

$$\text{LEADPROD}_{1,t} = \text{PROD}_{2,t}$$
$$\text{LEADPROD}_{2,t} = \text{PROD}_{3,t}$$
$$\text{LEADPROD}_{3,t} = \text{PROD}_{1,t+1}$$

LAGPROD = per capita onion production in pounds for *preceding* seasonal crop:

$$\text{LAGPROD}_{1,t} = \text{PROD}_{3,t-1}$$
$\text{LAGPROD}_{2,t} =$ January 1 storage stocks of late summer onions
$$\text{LAGPROD}_{3,t} = \text{PROD}_{2,t}$$

INCOME = average per capita U.S. disposable income in thousand dollars, deflated by consumer price index, 1957-59 = 100.

The acreage, production, and income variables were expressed on a per capita basis to adjust for population increases. Price and income variables were deflated to adjust for inflation. The variable OBSPRICE is a proxy for the observed grower-level price viewed at planting. It is not entirely appropriate since it reflects sales occurring after as well as during and before planting. The trend variable is used to represent changes in technology in the supply relation, and changes in consumer tastes and preferences in the demand relation. The variables LEADPROD and LAGPROD are proxies for competing onion supply from following and preceding seasonal crops. As in the case of OBSPRICE, these variables are not wholly appropriate, as they include production over and above that which directly competes with production from the relevant seasonal crop. However, more appropriate competing supply variables were not available except for the case of LAGPROD for the early spring crop. In this case, USDA published estimates of January 1 storage stocks of late summer onions are used to represent supply in competition with early spring production. The income variables used are averages of the seasonally adjusted annual rates for the quarters during which most of the specific crops are generally sold. Deflators are for the second calendar years of the seasons. Data used and their sources are provided in appendix A.

Equations (1) and (2) were estimated for the three seasonal crops by ordinary least-squares regression, using data for 1946/47-1969/70.[10] While it would be desirable to compare the structure of supply before, during, and after trading, planted acreage data were not available prior to 1946. Use of harvested acreage as a proxy was attempted, but a change in the methods of reporting acreage occurred in 1938, and appropriate adjustments could not be made. Consequently, comparison of supply structure is limited to the trading (1946/47-1958/59) and post-trading (1959/601969/70) periods. To maintain consistency, the demand relationships were estimated for the same periods.

Test for Changes in Structure

To determine possible differences in the structure of onion supply and demand between the futures trading and post-futures trading periods, equations (1) and (2) were separately estimated for the periods 1946/47-1958/59, 1959/60-1969/70, and 1946/47-1969/70. All of the previously defined explanatory variables were included, without regard for the statistical significance of the estimated coefficients or their signs relative to prior expectations. The estimated results are shown in tables 5 and 6.

At first sight, the estimated relations for 1946/47-1958/59 and 1959/60-1969/70 appear quite different. The magnitude of the coefficients differs substantially between periods and, in many cases, the coefficients have opposite signs. However, inspection of the standard errors of the coefficients suggests that differences between the periods might be minimal. In an intuitive sense, the standard errors measure how accurately the coefficients are estimated. The point estimate of the coefficient is the mean of a probability distribution of values, and the standard error indicates the standard deviation, or the variability of the distribution. While the coefficients for the supply and demand equations for the separate periods are different, their probability distributions overlap; consequently, observed differences may not be statistically significant.

As an example, consider figure 5, where b_i^1 and b_i^2 are point estimates of the coefficients for the i^{th} variable for periods 1 and 2, respectively. Although b_i^2 is larger than b_i^1, the probability distributions overlap. In fact, the intervals b_i^1 plus one standard error(sb_i^1) and b_i^2 minus one standard error (sb_i^2) partially coincide, as denoted by the crosshatched area.

Table 7 shows the incidence of such overlap for each of the variable coefficients in the seasonal supply and demand relations. A plus sign in the ±1.0 S.E. column for the relevant variable indicates that the interval consisting of b_i^1 plus one associated standard error overlaps the interval consisting of b_i^2 minus one associated standard error, where b_i^1 and b_i^2 are the smallest and largest, respectively, of the estimated coefficients for the 1946/47-1958/59 and 1959/60-1969/70 periods. The ±2.0 S.E. column is similarly interpreted. Note that in all cases, overlap occurs at ± two standard errors, while in 20 of 27 cases,

[10]Data plotting and experimentation with alternative functional forms for the supply and demand equations did not indicate nonlinear relationships to be more appropriate, with the possible exception of the demand relation for the late summer crop. In comparison, Shuffett (*3*) and Suits and Koizuma (*4*) used first differences of logarithms in onion market models for earlier periods.

Table 5 —Seasonal onion supply relations in futures, post-futures, and combined periods[1]

Season and time period	Intercept	Explanatory variables				R^2
		$ACRES_{t-1}$	$PRICE_{t-1}$	OBSPRICE	TREND	
Late summer:						
1946/47-1958/59	591.34	-0.15 [2](0.45)	-0.08 (12.12)	-3.77 (6.77)	-15.33 (6.41)	.85
1959/60-1969/70	-34.34	1.01 (.38)	10.00 (3.72)	-0.06 (1.50)	-0.21 (1.25)	.85
1946/47-1969/70	154.38	0.613 (.20)	12.80 (6.06)	-2.58 (3.90)	-3.28 (1.84)	.89
Early spring:						
1946/47-1958/59	302.07	-0.08 (0.38)	1.40 (25.51)	36.02 (35.23)	-14.92 (8.70)	.40
1959/60-1969/70	57.45	0.38 (0.39)	2.77 (3.08)	7.82 (8.96)	-2.31 (1.84)	.59
1946/47-1969/70	272.18	-0.14 (0.23)	4.61 (11.44)	28.20 (18.40)	-12.51 (3.15)	.64
Intermediate:						
1946/47-1958/59	83.40	0.29 (0.30)	9.62 (6.05)	-0.65 (6.86)	-1.12 (1.94)	.29
1959/60-1969/70	-54.35	0.86 (0.19)	12.26 (4.70)	6.06 (4.40)	0.03 (0.99)	.78
1946/47-1969/70	33.78	0.55 (0.19)	11.66 (4.29)	1.50 (4.59)	-1.84 (0.80)	.66

[1] Dependent variable is ACRES. See text (pp. 9-10) for description of variables. [2] Figures in parentheses are standard errors of the estimated coefficients.

Table 6 —Seasonal onion demand relations in futures, post-futures, and combined periods[1]

Season and time period	Intercept	Explanatory variables					R^2
		PROD	LEADPROD	LAGPROD	INCOME	TREND	
Late summer:							
1946/47-1958/59	9.85	-0.95 [2](0.21)	0.73 (0.41)	0.31 (0.46)	1.07 (6.39)	-0.22 (0.28)	.88
1959/60-1969/70	14.43	- 1.17 (0.43)	-0.35 (0.60)	-0.04 (0.69)	0.43 (4.84)	0.01 (0.34)	.74
1946/47-1969/70	7.75	- 0.86 (0.16)	0.16 (0.31)	0.03 (0.35)	2.25 (1.69)	-0.13 (0.09)	.70
Early spring:							
1946/47-1958/59	22.03	-2.02 (1.21)	-1.86 (0.75)	-0.81 (0.92)	-5.15 (9.72)	0.30 (0.35)	.57
1959/60-1969/70	14.27	-4.40 (0.81)	-2.94 (0.93)	0.44 (1.30)	4.40 (9.08)	-0.42 (0.65)	.89
1946/47-1969/70	13.15	-2.81 (0.65)	-1.93 (0.56)	-0.26 (0.54)	0.53 (2.49)	-0.01 (0.13)	.60
Intermediate:							
1946/47-1958/59	7.82	-1.63 (0.73)	1.66 (1.00)	-0.23 (0.39)	-1.20 (8.76)	0.19 (0.30)	.65
1959/60-1969/70	-7.27	-2.10 (0.93)	-1.17 (0.67)	0.16 (0.38)	7.64 (6.35)	-0.49 (0.50)	.65
1946/47-1969/70	5.19	1.45 (0.52)	0.62 (0.56)	-0.11 (0.31)	0.39 (2.22)	0.09 (0.12)	.44

[1] Dependent variable is PRICE. See text (pp. 9-10) for description of variables. [2] Figures in parentheses are standard errors of estimated coefficients.

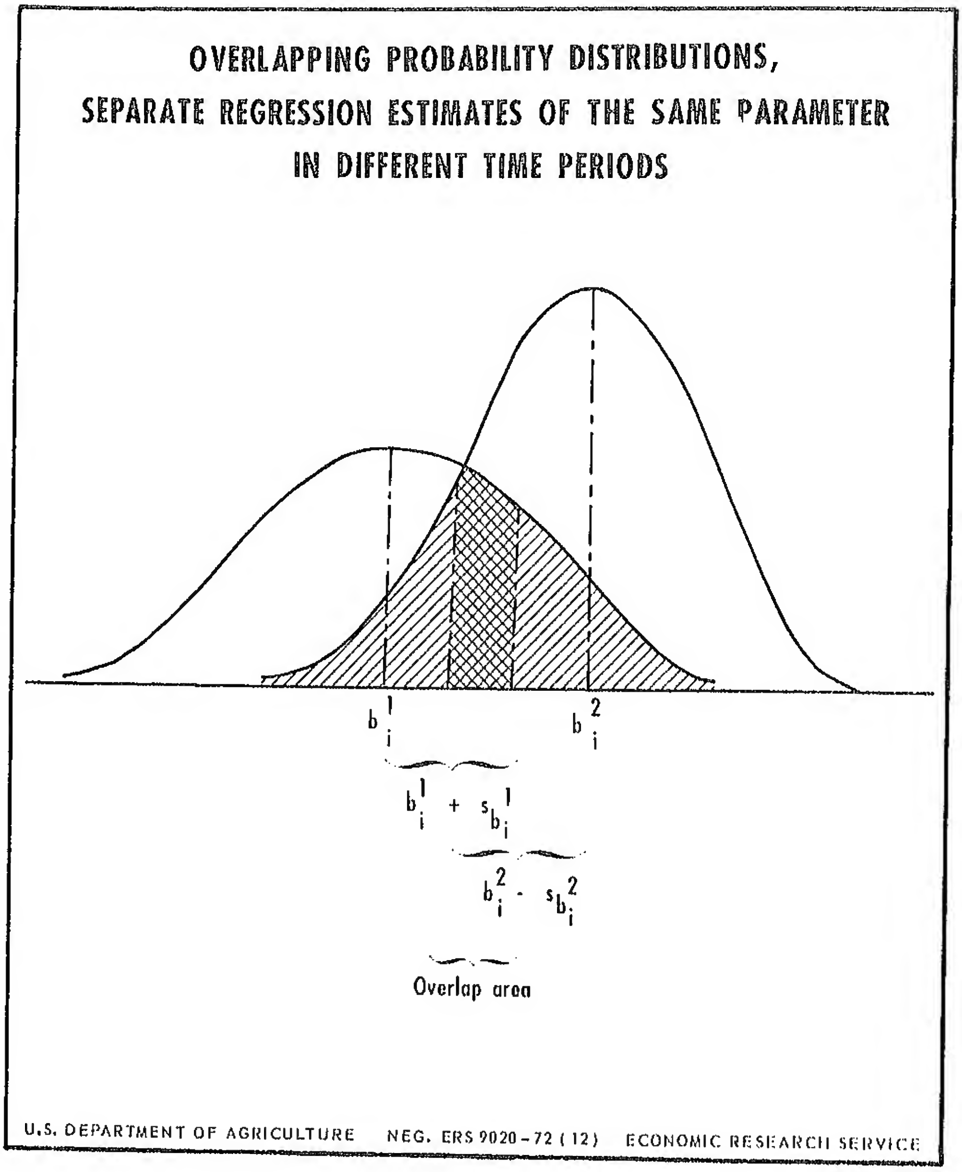


Figure 5

Table 7—Overlap of probability distributions of estimated regression coefficients, onion supply and demand relations, 1946/47-1958/59 and 1959/60-1969/70[1]

Variables[2]	Late summer		Early spring		Intermediate	
	±1.0 S.E.	±2.0 S.E.	±1.0 S.E.	±2.0 S.E.	±1.0 S.E.	±2.0 S.E.
Supply:						
$ACRES_{t-1}$	—	+	+	+	—	+
$PRICE_{t-1}$	+	+	+	+	+	+
OBSPRICE	+	+	+	+	+	+
TREND	—	+	—	+	+	+
Demand:						
PROD	+	+	—	+	+	+
LEADPROD	—	+	+	+	—	+
LAGPROD	+	+	+	+	+	+
INCOME	+	+	+	+	+	+
TREND	+	+	+	+	+	+

[1] The symbol (+) indicates that the intervals $b_i^1 \pm s_{b_i^1}$ $(2s_{b_i^1})$ and $b_i^2 \pm s_{b_i^2}$ $(2s_{b_i^2})$ overlap, where b_i^1 and b_i^2 are the regression estimated coefficients for the i^{th} variable for period 1 (1946/47-1958/59) and period 2 (1959/60-1969/70), respectively, and $s_{b_i^1}$ and $s_{b_i^2}$ are the associated standard errors of the estimated coefficients. [2] See text (pp. 9-10) for explanation of variables.

overlap occurs at ± one standard error. It should be emphasized that this does not constitute a statistical test of the comparability of the supply and demand functions for the two periods. On the other hand, it does suggest that no unequivocal statement regarding differences can be made.

A statistical test is available for determining whether the estimated supply and demand relations for the two periods are significantly different. Given each of the seasonal supply and demand relations for the 1946/47-1958/59 period, the hypothesis tested is that the observations from the 1959/60-1969/70 period do *not* come from the same relation. The mechanics of the test and the statistics generated are described in appendix B.

The results show that for the six pairs of seasonal relations (supply and demand relations for the three seasonal crops during the two time periods), the hypothesis is rejected. That is, the test provides no statistical proof that the relations estimated for the futures trading and post-futures trading periods are different.

Interpretation of System Structure

Since there is no evidence of significant differences in structure between the during and after trading periods, it is reasonable to pool observations for the two periods in representing structure. The estimated results of combining the periods are shown in tables 5 and 6. Many of the estimated coefficents have relatively large standard errors, suggesting that the associated variables may not influence supply and demand and add little to the structural equations. Insignificant variables were subsequently omitted through a sequential elimination process. For each seasonal relation, this involved omitting the variable judged least significant on the basis of coefficient t values and reestimating the equation. The process continued until remaining variables were statistically significant at the 90-percent level of confidence.[11]

Supply

The revised supply relations are shown in table 8. In the revised relations, the variable OBSPRICE—price observed at planting—was omitted from both the late summer and intermediate crop relations, while lagged acreage and lagged price proved insignificant in the early spring relation.

For late summer onion supply, the coefficient for $PRICE_{t-1}$ indicates that a $1 increase in lagged grower price results in a planting increase of about 12 acres per million population. In relative terms, a 1-percent change in lagged price yields a per capita change in planted acreage of about 0.1 percent.[12] The estimated trend coefficient is negative, and shows late summer acreage declining at an annual rate of 3½ acres per million population. The R^2 value of .89 indicates that about 90 percent of the variability in the dependent variable is associated with variation in the three included explanatory variables.

The variables OBSPRICE and TREND account for 64 percent of the variability in early spring planted acreage. The price coefficient suggests that growers are influenced significantly by the price of late summer onions in determining plantings. A 1-percent change in the season average late summer price yields a .4-percent change in early spring planted acreage. A strong negative trend in early spring acreage is shown by the trend coefficient. Net of the effect of OBSPRICE, acreage declined annually by more than 12 acres per million population over the estimation period.

The revised intermediate crop equation contains the same variables as the late summer equation, but the proportion of "explained" year-to-year variation in planted acreage is substantially smaller for the intermediate crop. While the lagged price coefficient for the intermediate crop is almost the same as for the summer crop, the percentage change in plantings resulting from a 1-percent change in lagged price is about .3—more than three times the comparable relative effect noted for the late summer crop. The trend coefficient shows a net annual decline in per capita plantings of 1.8 acres per million population.

Demand

Revised structural demand equations are shown in table 9. Of the five variables initially considered, only

[11] Technically, this is known as backwards stepwise regression.

[12] In this and following discussion, relative changes refer to flexibilities calculated at the mean values of the relevant variables over the time period used for estimation.

Table 8—Structural supply relations, seasonal onion crops, 1946/47-1969/70[1]

Season	Intercept	$ACRES_{t-1}$	$PRICE_{t-1}$	OBSPRICE	TREND	R^2	S.E.E.[2]	D—W[3]
Late summer	153.37	0.60 [4](0.20)	11.87 (5.81)		-3.48 (1.78)	.89	22.51	2.00
Early spring	277.45			30.19 (15.57)	-12.17 (2.01)	.64	63.65	2.09
Intermediate	37.44	0.55 (0.19)	11.75 (4.18)		-1.79 (0.77)	.66	18.18	2.27

[1] See footnotes to table 9.

Table 9—Structural demand relations, seasonal onion crops, 1946/47-1969/70[1]

Season	Intercept	PROD	LAGPROD	TREND	R^2	S.E.E.[2]	D--W[3]
Late summer	10.54	-0.77 [4](0.12)			.66	0.54	1.58
Early spring	13.53	-2.77 (0.59)	-1.93 (0.40)		.59	0.90	2.41
Intermediate	5.50	-1.48 (0.49)		0.12 (0.03)	.40	0.93	1.94

[1]See text (pp. 9-10) for explanation of variables. [2]Standard Error of Estimate. [3]Durbin-Watson Statistic. Test for serial correlation negative. [4]Figures in parentheses are standard errors of coefficients.

three are included in the demand model. Seasonal production proved significant in all of the relations. Other significant variables are LAGPROD (January 1 storage stocks) in the early spring relation and the trend variable for intermediate crop demand.

Sixty-six percent of the year-to-year variability in season average farm price for late summer onions is associated with variation in per capita seasonal production, the only variable judged significant in the revised demand model. One-pound increases in per capita late summer production decrease grower price by 77 cents per hundredweight. Price flexibility calculated at the mean 1946/47-1969/70 values of price and production is 3.0, which translates to a demand elasticity value of .33. This indicates that the demand for late summer onions is highly inelastic; increases in production tend to decrease total grower returns (season average price times total seasonal production).

In contrast, the elasticity of demand for the early spring crop is about unity, suggesting that changes in per capita production will have little effect on total grower returns. In terms of their relative impact on early spring price, changes in the supply of competing onions from the late summer crop are more important than changes in seasonal production. A 1-percent increase in per capita production decreases price by 1.04 percent, while a 1-percent increase in the January 1 storage stocks variable is associated with a 1.4-percent price decline.

The elasticity of demand for intermediate crop onions is also unity, indicating that a percentage change in production will result in the same percentage price change with the opposite sign. The trend variable also proved significant for the intermediate demand relation, and shows a net price increase of 12 cents per year at the grower level. The proportion of price variablility explained for the intermediate crop was only .40. This is substantially smaller than for the other two crops, and suggests that unidentified factors are responsible for much of the intermediate crop price variability.

The estimated price elasticity for the late summer crop (.33) is almost identical with that obtained by Shuffett (.34) for 1921-41 *(3)*. This suggests that the structure of demand for the late summer crop differed little in the period before onion futures trading from the periods during and after. On the other hand, Shuffett obtained a demand elasticity value of .40 for the early and intermediate seasons combined. This compares with 1.0 for each crop separately obtained in this study.

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APPENDIX A: DATA USED FOR ESTIMATION OF SEASONAL SUPPLY AND DEMAND MODELS

Appendix table 1A—Late summer season production data, 1930/31-1969/70

Crop year	Planted acreage	Harvested acreage	Yield	Production	Season av. farm price
	1,000 acres	*1,000 acres*	*Cwt. per acre*	*1,000 cwt.*	*Dollars per cwt.*
1930/31		55,980	204.0	11,420	.77
1931/32		49,960	147.3	7,359	1.40
1932/33		56,490	202.1	11,417	.39
1933/34		50,620	182.7	9,248	1.03
1934/35		47,280	169.8	8,028	1.07
1935/36		57,480	177.0	10,174	1.04
1936/37		53,900	217.7	11,734	.72
1937/38		52,230	200.6	10,477	1.31
1938/39		54,840	205.4	11,264	1.07
1939/40		62,760	229.5	14,403	.88
1940/41		60,380	219.0	13,223	1.12
1941/42		56,350	223.5	12,594	2.08
1942/43		62,350	229.5	14,309	2.04
1943/44		57,250	209.5	11,994	3.18
1944/45		78,710	233.5	18,379	2.04
1945/46	[1]	66,790	213.5	14,260	3.28
1946/47	73,280	71,880	265.5	19,084	1.40
1947/48	61,760	60,710	223.5	13,569	4.66
1948/49	65,300	63,490	259.5	16,476	1.98
1949/50	69,800	67,600	229.0	15,480	2.92
1950/51	70,800	67,620	261.0	17,648	1.60
1951/52	67,810	64,710	246.0	15,919	3.19
1952/53	58,900	57,110	260.0	14,849	4.25
1953/54	63,050	59,850	308.0	18,434	1.12
1954/55	60,100	57,430	296.0	16,999	1.96
1955/56	59,800	56,360	285.0	16,063	2.22
1956/57	58,250	56,470	308.0	17,393	2.08
1957/58	59,410	56,070	303.0	16,989	2.35
1958/59	58,500	53,290	308.0	16,413	3.49
1959/60	60,930	57,930	320.0	18,537	1.67
1960/61	59,400	56,710	335.0	18,997	2.23
1961/62	57,230	55,060	313.0	17,234	4.07
1962/63	58,610	55,720	341.0	19,001	2.39
1963/64	58,670	56,610	333.0	18,851	3.11
1964/65	60,140	57,580	310.0	17,850	2.85
1965/66	61,180	58,080	358.0	20,793	2.51
1966/67	59,110	57,560	315.0	18,131	4.30
1967/68	60,470	58,500	318.0	18,603	4.06
1968/69	62,520	60,170	337.0	20,278	2.92
1969/70[2]	61,250	58,950	333.0	19,630	3.75

[1] Planted acreage data not available for years prior to 1946/47. [2] Preliminary.

Sources: *(6)* *(7)* *(13)*.

Appendix table 1B—Early spring season production data, 1930/31-1969/70

Crop year	Planted acreage	Harvested acreage	Yield	Production	Season av. farm price
	1,000 acres	*1,000 acres*	*Cwt. per acre*	*1,000 per cwt.*	*Dollars per cwt.*
1930/31		19,550	113.4	2,217	1.35
1931/32		24,850	112.1	2,786	1.70
1932/33		19,650	69.0	1,356	1.16
1933/34		25,150	72.9	1,833	1.16
1934/35		26,550	69.8	1,853	2.72
1935/36		34,970	94.4	3,301	.78
1936/37		55,730	38.2	2,129	1.59
1937/38		64,080	33.8	2,166	1.25
1938/39		48,000	37.5	1,800	1.10
1939/40		28,300	37.5	1,061	3.40
1940/41		18,000	50.0	900	3.00
1941/42		40,000	60.0	2,400	1.80
1942/43		28,000	62.5	1,750	4.40
1943/44		70,600	40.0	2,824	4.20
1944/45		57,100	37.5	2,141	3.00
1945/46	([1])	58,300	47.5	2,769	3.50
1946/47	36,400	36,400	57.5	2,093	2.60
1947/48	51,000	49,000	45.0	2,205	5.90
1948/49	56,500	33,400	40.0	1,336	2.90
1949/50	71,700	45,700	42.5	1,942	2.30
1950/51	14,400	9,200	110.0	1,012	5.40
1951/52	40,200	38,800	55.0	2,134	7.20
1952/53	46,600	46,600	60.0	2,796	2.30
1953/54	39,500	39,500	55.0	2,173	2.50
1954/55	38,000	37,600	62.0	2,331	3.20
1955/56	51,000	50,000	80.0	4,000	2.80
1956/57	31,500	30,000	90.0	2,700	4.45
1957/58	29,800	27,000	95.0	2,565	4.15
1958/59	34,000	33,000	65.0	2,145	5.40
1959/60	29,500	25,000	110.0	2,750	2.95
1960/61	22,500	19,500	130.0	2,535	3.45
1961/62	25,500	22,300	120.0	2,676	4.60
1962/63	24,000	22,600	130.0	2,938	4.15
1963/64	27,900	24,600	155.0	3,813	2.75
1964/65	25,100	23,100	130.0	3,003	3.95
1965/66	23,100	16,300	95.0	1,549	7.50
1966/67	24,000	23,000	165.0	3,795	4.05
1967/68	27,000	21,500	115.0	2,473	6.85
1968/69	25,000	21,000	145.0	3,045	3.25
1969/70[2]	21,500	20,000	165.0	3,300	5.79

[1] Planted acreage data not available for years prior to 1946/47. [2] Preliminary.

Sources: *(6)* *(7)* *(13)*.

Appendix table 1C—Intermediate season production data, 1930/31-1969/70

Crop year	Planted acreage	Harvested acreage	Yield	Production	Season av. farm price
	1,000 acres	*1,000 acres*	*Cwt. per acre*	*1,000 cwt.*	*Dollars per cwt.*
1930/31		8,120	163.3	1,326	1.26
1931/32		10,330	165.1	1,706	.89
1932/33		9,100	161.1	1,466	1.37
1933/34		12,390	150.4	1,863	1.41
1934/35		16,600	147.4	2,447	1.38
1935/36		20,200	108.5	2,192	.93
1936/37		26,500	81.0	2,157	1.08
1937/38		19,410	82.6	1,605	1.31
1938/39		25,060	84.1	2,110	.90
1939/40		24,210	89.0	2,155	2.05
1940/41		26,410	80.2	2,120	2.61
1941/42		35,750	77.2	2,761	1.56
1942/43		28,050	68.8	1,931	3.41
1943/44		35,150	79.2	2,784	2.90
1944/45		19,680	123.8	2,437	4.27
1945/46	([1])	30,510	110.2	3,365	2.45
1946/47	24,020	23,870	112.9	2,696	2.80
1947/48	20,240	20,090	128.3	2,578	4.05
1948/49	23,540	21,460	119.9	2,574	3.06
1949/50	22,810	22,510	144.3	3,250	2.25
1950/51	27,850	27,500	112.4	3,092	3.45
1951/52	20,690	20,440	148.1	3,029	4.61
1952/53	25,800	25,400	159.1	4,042	2.10
1953/54	19,380	19,130	156.0	2,985	2.89
1954/55	20,370	20,270	150.2	3,046	2.52
1955/56	17,780	17,280	174.0	3,008	6.51
1956/57	27,640	24,340	191.2	4,655	3.72
1957/58	28,210	26,710	229.1	6,120	2.00
1958/59	26,310	22,490	218.0	4,904	2.82
1959/60	22,400	20,750	227.1	4,713	2.86
1960/61	17,290	16,690	229.7	3,835	4.32
1961/62	18,500	18,200	225.3	4,101	3.55
1962/63	16,750	16,350	244.8	4,004	4.72
1963/64	17,700	17,400	247.5	4,306	2.92
1964/65	16,300	16,000	267.2	4,276	5.47
1965/66	20,550	19,950	252.5	5,038	5.41
1966/67	24,700	22,000	272.0	5,984	3.53
1967/68	25,650	24,800	245.6	6,091	4.21
1968/69	22,150	20,450	261.0	5,338	4.07
1969/70[2]	19,800	19,800	271.7	5,379	4.28

[1] Planted acreage data not available for years prior to 1946/47. [2] Preliminary.

Sources: *(6) (7) (13)*.

Appendix table 2A —Late summer data used for estimation of seasonal supply and demand relations, 1946/47-1969/70[1]

CROP YEAR	ACRES	PRICE	OBSPRICE	PROD	LEADPROD	LAGPROD	INCOME
1946/47	518.25	1.23	3.57	13.50	2.38	1.48	1.74
1947/48	428.59	3.92	2.32	9.42	1.87	1.53	1.69
1948/49	445.43	1.92	4.96	11.24	1.76	0.91	1.81
1949/50	467.83	2.73	2.82	10.38	1.73	1.30	1.80
1950/51	466.71	1.28	2.15	11.03	2.14	0.67	1.83
1951/52	439.47	2.68	4.32	10.32	2.00	1.38	1.87
1952/53	375.16	4.05	6.05	9.46	1.93	1.78	1.95
1953/54	395.05	1.10	2.19	11.55	2.53	1.36	1.97
1954/55	370.07	2.04	2.45	10.47	1.84	1.44	2.01
1955/56	361.77	2.34	3.33	9.72	1.84	2.42	2.10
1956/57	346.31	2.14	2.95	10.34	1.79	1.61	2.11
1957/58	346.82	2.26	4.59	9.92	2.72	1.50	2.14
1958/59	336.01	3.53	3.99	9.43	3.52	1.23	2.08
1959/60	344.04	1.69	5.45	10.47	2.77	1.55	2.17
1960/61	330.18	2.25	2.98	10.56	2.62	1.41	2.16
1961/62	312.73	4.03	3.48	9.42	2.10	1.46	2.25
1962/63	315.45	2.39	4.55	10.23	2.21	1.58	2.28
1963/64	311.08	3.17	4.15	10.00	2.12	2.02	2.37
1964/65	314.38	2.77	2.81	9.33	2.25	1.57	2.48
1965/66	315.85	2.28	3.83	10.73	2.21	0.80	2.61
1966/67	301.58	4.10	6.82	9.25	2.57	1.94	2.68
1967/68	305.10	3.76	3.86	9.39	3.02	1.25	2.73
1968/69	312.29	2.56	6.34	10.13	3.04	1.52	2.75
1969/70	302.92	3.23	2.85	9.71	2.64	1.63	2.79

[1] See text (pp. 9-10) for description of variables and units of measurement. Data source for all variables except INCOME is *(13)*. Data for INCOME, price deflators, and population are from *(10)*.

Appendix table 2B —Early spring data used for estimation of seasonal supply and demand relations, 1946/47-1969/70[1]

CROP YEAR	ACRES	PRICE	OBSPRICE	PROD	LEADPROD	LAGPROD	INCOME
1946/47	257.43	2.32	1.23	1.48	13.50	3.93	1.72
1947/48	353.92	4.96	3.92	1.53	9.42	2.37	1.78
1948/49	385.40	2.82	1.92	0.91	11.24	3.75	1.77
1949/50	480.56	2.15	2.73	1.30	10.38	3.24	1.85
1950/51	94.92	4.32	1.28	0.67	11.63	3.85	1.89
1951/52	260.53	6.05	2.68	1.38	10.32	2.77	1.88
1952/53	296.82	2.19	4.05	1.78	9.46	2.42	1.99
1953/54	247.49	2.45	1.10	1.36	11.55	3.96	1.95
1954/55	233.99	3.33	2.04	1.44	10.47	3.08	2.06
1955/56	308.53	2.95	2.34	2.42	9.72	2.70	2.13
1956/57	187.28	4.59	2.14	1.61	10.34	2.75	2.13
1957/58	173.96	3.99	2.26	1.50	9.92	2.61	2.19
1958/59	195.29	5.45	3.53	1.23	9.43	2.51	2.09
1959/60	166.57	2.98	1.69	1.55	10.47	3.21	2.19
1960/61	125.07	3.48	2.25	1.41	10.56	2.94	2.20
1961/62	139.34	4.55	4.03	1.46	9.42	2.40	2.28
1962/63	129.17	4.15	2.39	1.58	10.23	2.71	2.31
1963/64	147.93	2.81	3.17	2.02	10.00	2.46	2.45
1964/65	131.21	3.83	2.77	1.57	9.33	2.53	2.54
1965/66	119.26	6.82	2.28	0.80	10.73	2.99	2.65
1966/67	122.45	3.86	4.10	1.94	9.25	2.19	2.73
1967/68	136.23	6.34	3.76	1.25	9.39	2.42	2.82
1968/69	124.88	2.85	2.56	1.52	10.13	2.72	2.82
1969/70	106.33	4.99	3.23	1.63	9.71	2.10	2.88

[1] See text (pp. 9-10) for description of variables and units of measurement. Data source for all variables except INCOME is *(13)*. Data for INCOME, price deflators, and population are from *(10)*.

Appendix Table 2C—Intermediate data used for estimation of seasonal supply and demand relations, 1946/47-1969/70[1]

CROP YEAR	ACRES	PRICE	OBSPRICE	PROD	LEADPROD	LAGPROD	INCOME
1946/47	169.87	2.46	1.23	1.91	1.48	9.60	1.78
1947/48	140.46	3.40	3.92	1.79	1.53	11.43	1.83
1948/49	160.57	2.97	1.92	1.76	0.91	10.56	1.76
1949/50	152.88	2.10	2.73	2.18	1.30	11.83	1.91
1950/51	183.59	2.76	1.28	2.04	0.67	10.49	1.89
1951/52	134.09	3.87	2.68	1.96	1.38	9.62	1.93
1952/53	164.33	2.00	4.05	2.57	1.78	11.74	1.98
1953/54	121.43	2.83	1.10	1.87	1.36	10.65	1.96
1954/55	125.43	2.62	2.04	1.88	1.44	9.89	2.10
1955/56	107.56	6.85	2.34	1.82	2.42	10.52	2.15
1956/57	164.33	3.84	2.14	2.77	1.61	10.10	2.15
1957/58	164.68	1.92	2.26	3.57	1.50	9.58	2.18
1958/59	151.12	2.85	3.53	2.82	1.23	10.65	2.13
1959/60	126.48	2.89	1.69	2.66	1.55	10.73	2.19
1960/61	96.11	4.36	2.25	2.13	1.41	9.58	2.22
1961/62	101.09	3.51	4.03	2.24	1.46	10.38	2.28
1962/63	90.15	4.72	2.39	2.16	1.58	10.15	2.34
1963/64	93.85	2.98	3.17	2.28	2.02	9.46	2.48
1964/65	85.21	5.31	2.77	2.24	1.57	10.87	2.61
1965/66	106.09	4.92	2.28	2.60	0.80	9.36	2.70
1966/67	126.02	3.36	4.10	3.05	1.94	9.49	2.77
1967/68	129.41	3.90	3.76	3.07	1.25	10.23	2.84
1968/69	110.64	3.57	2.56	2.67	1.52	9.81	2.89
1969/70	97.92	3.69	3.23	2.66	1.63	10.68	2.92

[1] See text (pp. 9-10) for description of variables and units of measurement. Data source for all variables except INCOME IS (*13*). Data for INCOME, price deflators, and population are from (*10*).

APPENDIX B: EQUALITY OF COEFFICIENTS TEST

The test used for determining comparability in the structure of onion supply and demand in the periods 1946/47-1958/59 and 1959/60-1969/70 is based on a test of equality between the regression coefficients for the estimated relations for each time period. Justification and assumptions necessary for using the procedure are provided in (*2*), pages 136-37.

For each relation, the test is conducted as follows: (1) The 24 yearly observations, 1946/47-1969/70, are pooled and least—squares estimates of the supply and demand parameters are obtained. (2) Separate estimates are made for the 13-year period 1946/47-1958/59 and the 11-year period 1959/60-1969/70. (3) The total error sum of squares for the two separate regressions (ESS_1 and ESS_2) are added, and their sum subtracted from the total error sum of squares for the pooled observations (ESS_{1+2}). (4) Then, the ratio:

$$\frac{[ESS_{1+2}-(ESS_1+ESS_2)]\,/k}{(ESS_1+ESS_2)\,/\,(24-2k)}$$

where k is the number of regressors in the relation, is distributed as F, with k and 24-2k degrees of freedom. (The test results are shown in app. table 3.)

As implied in the text, the calculated F ratios are not significant for any of the six supply and demand relations. Hence, the conclusion drawn was that given the appropriateness of the relations and the variables selected, there is no discernible difference in the structure of supply and demand between the periods 1946/47-1958/59 and 1959/60-1969/70.

The equality of coefficients test was conducted using all of the *a priori* specified variables in the supply and demand relations rather than the variables finally assessed significant for the individual seasonal crops. However, when tests were applied to the relations which omitted variables possessing coefficients not significantly different from zero, the results were comparable. This is expected, since what is being tested is the hypothesis $b_i^1 = b_i^2$; that is, the i^{th} coefficients in the two relations are the same. Consequently, if a coefficient is judged to be zero in either relation and the relation is reestimated omitting the nonsignificant variable, the results of the test should remain unchanged.

It is of interest to note the large differences in mean error sums of squares between the two time periods, particularly for the supply relations (app. table 3). The mean error sum of squares for the futures trading period (1946/47-1958/59) is 19 times as large as the mean error sum of squares for the post-futures period (1959/60-1969/70) in the late summer supply relation. For the early spring and intermediate crop seasons, the comparable factors are 71 and 6, respectively. This reflects the relative stability of planted acreage for all three crops in recent years and the resulting reduction in variability about the (different) means for the two time periods. However, even though the amount of variability in planted acreage was quite different, the results of the equality of coefficients tests suggest that the manner of influence of the explanatory variables included in the relations has not necessarily changed.

Appendix table 3—Results of testing equality of coefficients, supply and demand relations for 1946/47-1958/59, 1959/60-1969/70, and 1946/47-1969/70

Relation	Error sums of squares						F Ratio
	1946/47-1958/59		1959/60-1969/70		1946/47-1969/70		
	Total	*Mean*	*Total*	*Mean*	*Total*	*Mean*	
Supply:							
Late summer	6,051	756.4	235	39.2	9,906	521.4	2.30
Early spring	73,006	12,167.7	1,029	171.5	84,301	4,436.9	0.55
Intermediate	4,153	519.1	529	88.2	6,576	346.1	1.61
Demand:							
Late summer	1.38	0.20	1.60	0.32	5.77	0.32	2.62
Early spring	8.95	1.28	1.94	0.39	16.65	0.92	1.48
Intermediate	6.85	0.98	2.22	0.44	16.74	0.93	2.35